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1) Give the following IUPAC names of the following compounds.
$HCOOH$ – Methanoic acid
$HOOCCH_2CH_2CH_2COOH$ – pentan-1,5-dioic acid
$CH_3CH_2CH_2COOH$ – Butanoic acid
$HO_2C-CO_2H$ ~~ethan-1,2-dioic acid~~ ethan-1,2-dioic acid
$CH_3(CH_2)_4COOH$ – Hexanoic acid
$CH_3CH=CHCH_2CH_2COOH$ – Hex-4-enoic acid

2) Discuss briefly the physical properties of Carboxylic acids under the following heading
i physical appearance: All simple aliphatic carboxylic acids up to $C_{10}$ are liquids at room temperature. Most other carboxylic acids are solid at room temperature although anhydrous carboxylic acid (acetic acid) known as glacial ethanoic acid freezes to an ice-like solid below the room temperature
ii Boiling points: This increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass
iii solubility: lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water, this largely due to their ability to form hydrogen bonds with water molecules. The water solubility of the acids decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvent.

3) Write two industrial preparations of carboxylic acids
Ans: → From Carbon (II) oxide:
– Methanoic acid (formic acid) is manufactured by adding carbon (II) oxide under pressure to hot aqueous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with

tetraoxosulphate(vi) acid ($H_2SO_4$)

$$CO \xrightarrow{NaOH} HCOONa \xrightarrow{H_2SO_4} HCOOH + NaHSO_4$$

→ from ethanol

Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanol to ethanoic acid using manganite (ii) ethanoate (as catalyst. Ethanol itself is obtained from ethylene

$$HC \equiv CH \xrightarrow{dil\ H_2SO_4 / HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$$

4) With equations and brief explanation discuss the synthetic preparation of carboxylic acid

→ Oxidation of primary alcohol and aldehydes: The oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using oxidizing agent. ($K_2Cr_2O_7$ or $KMnO_4$) in acidic solution

$$RCH_2OH \xrightarrow{[O]\ excess\ acid/KMnO_4} RCHO \xrightarrow{[O]} RCOOH$$

5) With chemical equation only, outline the reduction, decarboxylation and esterification of carboxylic acid

i. Reduction:

$$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + 4H_2$$

$$\downarrow 4H_2O$$

$$4RCH_2OH + Al(OH)_3 + LiOH$$

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid → Butanol

ii) Decarboxylation:

$$CH_3CH_2CH_2COONa + NaOH \xrightarrow{Fuse} CH_3CH_2CH_3 + Na_2CO_3$$

Kolbe synthesis

$$2\,CH_3CH_2COONa + 2H_2O \xrightarrow{electrolysis/aq.\ CH_3OH} CH_3(CH_2)_2CH_3 + CO_2\,(anode) + 2NaOH + H_2\,(cathode)$$

iii) Esterification

$$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xrightarrow{H^+} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$$